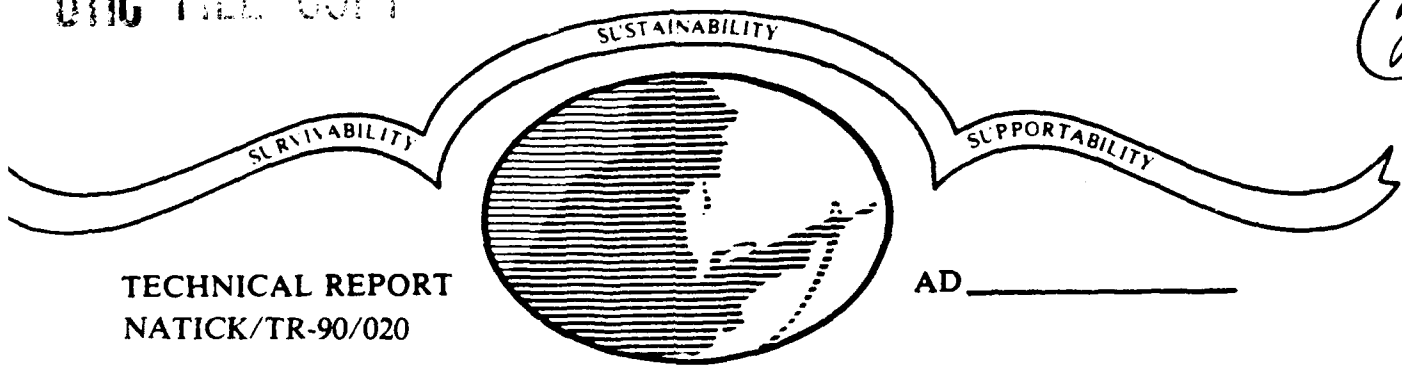


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TECHNICAL REPORT
NATICK/TR-90/020

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AD-A230 082

DEVELOPMENT OF A MULTIFUEL INDIVIDUAL/SQUAD STOVE

BY
DONALD W. PICKARD

FEBRUARY 1990

FINAL REPORT
OCTOBER 1986 TO SEPTEMBER 1989

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RESEARCH, DEVELOPMENT AND ENGINEERING CENTER
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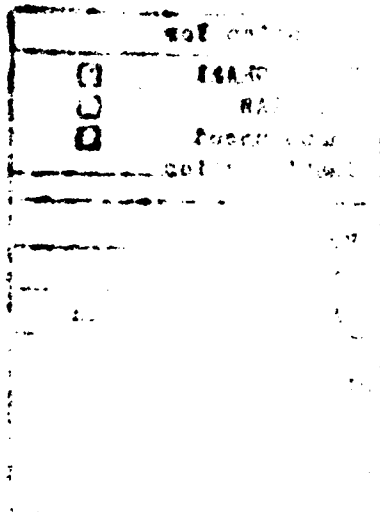
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PREFACE

Because the Department of Defense is converting tactical vehicles from gasoline to diesel fuels, there is a requirement to design a squad stove capable of burning diesel and any other field fuel to replace the gasoline burning M-1950 Model. This requirement has been met under the DOD Food Program Requirement (JSR) MA85-16, Project 1E464713D548. The objective of this project was to develop a squad stove that could burn any field-available liquid fossil fuel without the performance and operational deficiencies of the M-1950 model.

A multifuel squad stove has been designed, exhaustively tested, and adopted as a standard item replacing the previous version.



DEVELOPMENT OF A MULTIFUEL INDIVIDUAL/SQUAD STOVE

INTRODUCTION

The Department of Defense (DOD) conversion of tactical vehicles from gasoline to diesel fuel, and eventually to a universal fuel, JP-8, will reduce the availability of gasoline in theaters of operation. To provide essential food service flexibility, relevant equipment, such as a squad stove, must be able to use whatever fuel is available. The M-1950 gasoline stove is unable to burn diesel fuel and is, therefore, logistically obsolete.

The standard issue M-1950 gasoline stove has several additional shortfalls and deficiencies. It is dangerous to operate particularly at low ambient temperatures, because it is prone to flaring. The grill of the M-1950 is not compatible with the standard canteen cup. The case configuration is not useful for heating the Meal, Ready-To-Eat (MRE). The height to base ratio of the M-1950 causes it to be unstable and subject to accidental tipping and spills.

In response to this need, the United States Marine Corps (USMC) developed a requirement to replace the M-1950 with a multifuel stove that could burn diesel without the need for preheat pastes or fluids. The USMC Required Operational Capability (ROC) was approved, 4 February 1983. Headquarters, Department of the Army (HQDA), approved, with changes, the USMC ROC as an Army requirement document on 31 March 1986; see Appendices A & B.

The two greatest technological challenges of the ROC were: (1) provide clean and safe combustion of a wide range of fuels from highly volatile gasoline to nonvolatile diesel; and (2) burn these fuels without benefit of preheat pastes and fluids. Both requirements were eventually met. The only requirement of the ROC that has not been technologically feasible or practical

is providing "clean heated air" for an eight-hour period in a five-man arctic tent. The proponents agreed that this capability was no longer required, and the ROC was revised during the Milestone I/II In-Process Review (IPR).

This report will describe the technical approach taken to meet the design challenge, the steps taken to resolve key safety and operational problems, and the final design of the Multifuel Individual/Squad Stove (MISS).

TECHNICAL APPROACH

As a first step, to possibly avoid an expensive development effort, a market investigation was conducted by American and European firms to determine if a commercial or modified commercial stove could be adopted. Dozens of stoves were purchased and tested. None of the "so called" multifuel stoves would burn diesel, and stoves which could burn heavier fuels (such as kerosene) required separate preheat fuels. Contracts were then issued to two prominent stove manufacturers (Mountain Safety Research and Optimus). Their best efforts were not successful, primarily because their methods of preheating were inadequate. The primary proponents were asked to justify their requirement for not allowing a separate fuel for preheating (i.e. trioxane or ethyl alcohol). They responded by stating that unless Natick could prove that the requirement could not be met, the requirement would stand as is. To meet this particular requirement, a separate preheating device has been added to the stove design.

A stove was then fabricated in-house from several commercial components. A commercial vaporizing-type burner, originally designed to burn kerosene, was modified so that it could also burn diesel fuel and gasoline. To achieve the high temperatures necessary (750°F) to vaporize diesel and kerosene, an atomizing type preheater was added to the stove design. The preheater was essentially a mini blowtorch that atomized the fuel. The preheater required a large volume of air, at relatively high pressure in order to atomize the fuel so a large pump was added to the design (i.e., the M-1950 pump moves 0.8 cubic inches of air vs. 5.0 cubic inches for the MISS). After a repetitive series of modifications and evaluations, the requirement was met, and pasteless preheating and ignition were demonstrated.

Optimus of Sweden and Patria of Portugal have been marketing versions of the burner and preheater design for many years. This type of burner and preheater are the same design as will be found on the production MISS units. Franz Heinze KG of West Germany is under contract to provide 25,000 stoves, which use the burner and preheater, to the German Army. Test data and reports have been collected and are available if requested. Optimus of Sweden is under contract to provide a stove -- which uses the burner -- to the Swedish and Norwegian Armies. Optimus provided some test data. None of the stoves purchased met all requirements; however, a prototype fuel tank was fabricated in-house onto which commercial stove components (taken from the Non-Development Item (NDI)) were installed. This stove demonstrated the ability to meet requirements.

Following the successful demonstration, an in-house test was performed to determine the effective life of the burner and preheater. Prior to this test it was assumed that the burner vaporizer would become clogged after a limited number of hours (i.e., the Coleman Company has indicated its stove would become clogged after 60 hours of operation on automotive gasoline). A fixture was built for the testing of 10 burners and preheaters. Summer diesel (DF-2) was selected as a fuel, to represent worse case. Seven burners were operated for an average of 322.5 hours during which they were subjected to an average of 224 startups (86 minutes was the average run duration). The Mean Time Between Failure (MTBF) of each burner/preheater was 173 hours and 174 ignitions. The cleaning needle caused most of the minor failures and has since been reworked so the holders are firmly swaged around the needle. Still, a needle occasionally will separate from its holder and become stuck in the jet. For this reason a spare jet and needle have been provided with the stove's spare parts.

Most camp stoves, including the M-1950, are cylindrical. The MISS in its final version (Figure 1) is an atypical rectangular shape, 5 inches high, 4 inches wide, and 6-1/2 inches long, providing a low, stable cooking platform. The MISS has a vaporizing burner at one end of the rectangular tank and a built-in preheater at the other end. The primary difference between the MISS and other stoves is the preheater. The MISS also includes a fuel cap, pressure relief valves, pump, funnel, wrench, spare parts, and a fold-out instruction sheet. The MISS is stored inside a two quart aluminum case that is the right shape to hold MREs (up to seven). The MISS will melt a case of snow in 5 minutes, boil a quart of water in 5 minutes, and will operate at full fire (8500 Btu/h) on a tank of fuel (10 ounces) for one and a half hours.

With regard to MANPRINT elements of manpower, personnel training requirements, health hazard assessment, system safety and overall human factors engineering, testing has demonstrated the selected design with NDI components to be equal to or better than the M-1950. The MISS will require no additional manpower to operate or maintain, will not increase the training load, and will not introduce any new Military Occupational Speciality (MOS) to the force structure. The testing in cold regions demonstrated that the MISS presents less of a health hazard than the M-1950 with regard to the generation of hazardous combustion products in areas of limited ventilation. Warning labels on the stove and warnings on the instruction sheet caution operators against using the MISS in tents.

Several safety features have been incorporated in the MISS design. It has a lower, more stable profile than the M-1950. The standard canteen cup fits the grill without rocking. The MISS now has two pressure relief valves. One

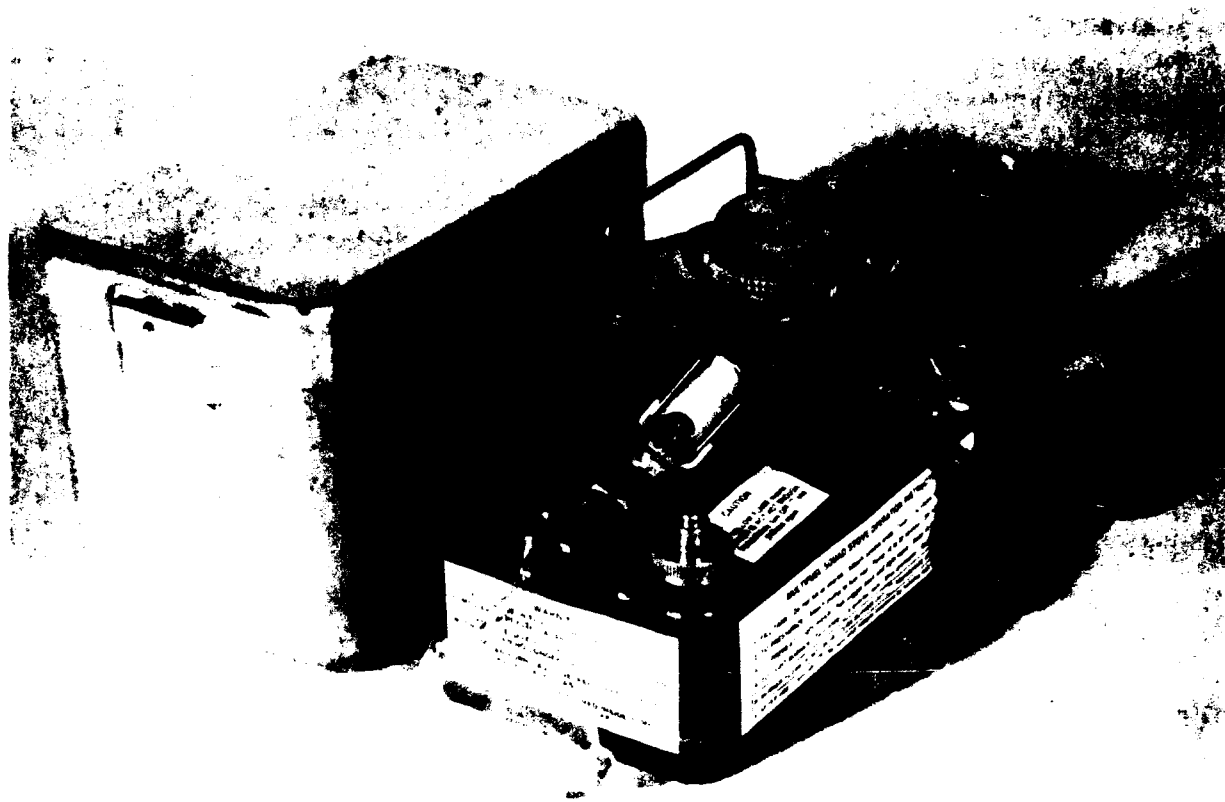


Figure 1. Multifuel Individual Squad Stove

valve is part of the fuel cap and protects against catastrophic failure of the tank. The other pressure relief valve was added following testing to prevent tank bulging, which occurred from overpressurizing with the hand pump. The pump also functions as a handle for the case, which serves as a cook pot. The M1950 case itself does not have a handle.

Human factors have also influenced the design of the MISS. The rectangular shape has permitted locating most of the operable hardware at one end of the tank, away from the burner. The pump, control knob, and preheater trigger have been carefully designed for an operator wearing standard five-finger U.S. Army issue leather gloves with wool inserts.

Supportability will be similar to the M-1950 gasoline stove. There are no unique maintenance requirements. Each stove will include: a small package of repair parts (nozzles, needles, packing, etc., stored inside the spare parts chamber of the pump handle); a multipurpose tool; an operation instruction label (installed on the side of tank); and a comprehensive set of operation and repair instructions (in the form of a fold-out sheet). No scheduled maintenance is planned. When the stove performance deteriorates (i.e., difficult to light, leaks, yellow flame, etc.) the stove operator can use the multipurpose tool to replace the nozzle, needle, packing, etc., in accordance with the operation and repair instructions. All maintenance will be performed at the organizational/unit level. No maintenance beyond general cleaning, inspections, adjustments and replacement of components is envisioned. Anything beyond these types of preventative maintenance actions would require discarding the entire MISS. Provisioning on the stove will cover critical organizational repair parts, such as the preheater, pump, funnel, control knob/wrench, case, and burner parts that will be stocked at the organizational level.

There is no need for formal training. Each stove will come with a comprehensive set of operation and repair instructions. Training Outlines and Instructor/Lesson Guides have been prepared and are available. A comprehensive "Use and Care" video has been produced and will be supplied to various training sites. To assist the first time user of the stove, an "Operation and Repair Instruction" fold-out sheet has been prepared. It was decided that due to the compact size of the stove, a standard (8-1/2 X 11) DA TM would be of limited usefulness to the stove operator. Both a multipage pamphlet and fold-out sheet were printed in a stove size (4 X 5-1/2) format and tested. The fold-out has been made a part of the stove drawing package, and will be stored inside the stove case. The original strategy was to publish the Operation and Repair instruction sheet as a Technical Manual, and include all of the required information for ordering spare parts. This approach has since been modified. The current strategy is to include the instruction sheet in the technical data package for use with the item, and have the first production contract include the preparation of a standard -12&P combined operation, maintenance and repair parts special tool list Technical Manual.

The survivability of the MISS will be similar to the M-1950. Due to the use of standard and commercially available parts, the MISS will be affordable, costing slightly more than the M-1950 and similar to commercial multifuel stoves. With the capability to provide hot food and melt snow for water, the MISS will improve combat readiness. The MISS is sustainable with any fuel drained from vehicles or obtained locally. The manpower requirements are limited to one operator per stove, which is adequate to heat rations and melt snow for squad-size groups of soldiers.

Relative to cost, this program has been considered an NDI "integration of components." The commercial availability of components, low technology, and unsophisticated manufacturing requirement will provide unlimited competition. A well-defined military specification and drawing package has been prepared, which will allow a full and open competitive fixed-price production contract. Therefore, no cost growth is expected.

TEST AND EVALUATION

The Multifuel Individual/Squad Stove has been subjected to four separate independent operational tests by the U.S. Marine Corps and U.S. Army. The stove has also been subjected to independent technical tests that include tropical and cold region environments. The tests were designed to provide information for independent technical and operational assessments of the stove's ability to meet the requirements, issues, and criteria. The tests covered performance, reliability, and MANPRINT, with particular emphasis on safety and health. Information was collected on combustion products by U.S. Army Research Institute of Environmental Medicine (USARIEM) in their hypobaric chamber and by Cold Regions Test Center (CRTC) at sea level and 12,000 ft, with all of the required fuels, and in two standard tents (the five-and ten-man arctic tents).

The series of tests identified several materiel defects, including: bulging tanks, broken pump handles, cracked fittings, leaking fuel caps, gasket failures, and at Tropic Test Center (TTC), difficulties preheating with the local diesel. All of the problems were corrected, most of the operational requirements were met, and the basic design was found to be sound. The stoves were prototypes and some material defects were expected. The drawings have been updated to correct the deficiencies. Stoves have been retrofitted with separate pressure relief valves to correct bulging, stronger pump handles, a fuel cap filter, and a fiberglass wick to aid preheating. The retrofitted stoves were tested at CRTC from January to March 1989 in a Technical Check Test, which confirmed that deficiencies have been corrected.

A list of the deficiencies -- which surfaced during testing -- that were related to safety and hazards, and the corresponding corrective actions, are given in Appendix C. Additional characteristics related to performance and reliability as they exist in the final design are included in Appendix D.

CONCLUSIONS

The Multifuel Individual Squad Stove (MISS) has been type classified; that is, introduced into the military supply system and included in organizational equipment lists as the standard squad stove, gradually replacing the obsolete M-1950 gasoline model. A military specification, Appendix E, has been prepared.

This stove provides a multifuel capability, including diesel and JP-8, with ignition possible without resorting to auxiliary gelled fuels. The lower profile provides stability and the overall configuration facilitates the stove's use to heat MRE entrees and to rapidly melt snow.

In addition to meeting the essential requirements, the MISS has several features that enhance its utility and supportability:

- * The case and lid have slots designed so that they can be used as a "cook pot" or "frying pan," using the air pump as a handle.

- * The wrench is also the control knob. The handle end of the wrench shaft fits around the control valve stem and the multislot end is enclosed in an insulating polymer/rubber protective cover for turning.

- * The shaft of the air pump is hollow and large enough to hold spare parts and small cleaning aids.

APPENDIX A

U.S. Marine Corps Required Operational Capability (ROC)

for a Lightweight, One-burner Stove



DEPARTMENT OF THE NAVY
HEADQUARTERS UNITED STATES MARINE CORPS
WASHINGTON, D.C. 20380

IN REPLY REFER TO
ROC-2-19-avs
4 FEB 1983

From: Commandant of the Marine Corps
To: Distribution List

Subj: Required Operational Capability (ROC) No. LOG 1.62 for
a Lightweight, One-burner Stove

Ref: (a) MCO 3900.4B

Encl: (1) ROC No. LOG 1.62 for a Lightweight, One-burner Stove

1. This letter establishes and promulgates ROC No. LOG 1.62 for a Lightweight, One-Burner Stove. The ROC has been developed in accordance with the reference and is contained in the enclosure.

2. The Commanding General, Marine Corps Development and Education Command (Director, Development Center) is the Marine Corps point of contact for the development efforts pertaining to the Lightweight, One-burner Stove.

Eugene B. Russell
Eugene B. RUSSELL
DEPUTY CHIEF OF STAFF FOR RD&S

DISTRIBUTION LIST:
(See attached)

REQUIRED OPERATIONAL CAPABILITY (ROC) No. LOG 1.62
FOR A
LIGHTWEIGHT, ONE-BURNER STOVE

1. STATEMENT OF THE REQUIREMENT. Marines engaged in combat operations in cold weather environments require a small, lightweight stove to heat rations and water for fire team and squad sized groups. An Initial Operational Capability (IOC) of FY 1987 is required.

2. THREAT AND OPERATIONAL DEFICIENCY

a. Threat. Not applicable.

b. Operational Deficiency. The conversion of tactical vehicles from gasoline to diesel fuel will reduce the availability of gasoline in Marine Air-Ground Task Forces beginning in FY 1985. The Stove, Gasoline Burner, M1950 (Squad Stove) which has been used extensively by Marine Corps units engaged in cold weather operations cannot burn diesel fuel and its design causes it to be marginally stable when used for cooking. This creates a hazard to the occupants of small shelters. The reliability of this stove has also been poor in cold environments. A new stove with a stable, low profile design and capable of burning a variety of fuels would provide a safer and logistically simpler item.

3. OPERATIONAL AND ORGANIZATIONAL CONCEPTS

a. Operational Concept. The Lightweight, One-burner Stove will be used as a cooking and heating unit for groups of from two to five men operating in an isolated or forward area where the use of field mess cooking equipment is not practical.

b. Organizational Concept. The Lightweight, One-burner Stove will be issued as a one-for-one replacement for the Stove, Gasoline Burner, M1950.

c. Training and Support Requirements

(1) No formal specialized training will be required for the user.

(2) The Stove will require user maintenance similar to that required for the replaced item.

(3) Impact on the Marine Corps supply system will be minimal. Development of a small multifuel stove will reduce the types of fuel necessary in an area of operations, thereby simplifying logistic support.

Enclosure (1)

4. ESSENTIAL CHARACTERISTICS. The Lightweight, One-burner Stove will:

a. Be capable of burning diesel fuel, kerosene, aviation fuel (JP-4/5), or gasoline (leaded or unleaded) efficiently from sea level to 12,000 ft above sea level.

b. Be capable of producing a minimum of 9000 BTUs at sea level.

c. Weigh no more than 2 lbs (907g) complete, dry weight; 1.5 lbs (680g) desired.

d. Have a maximum external volume of 210 in³ (3441 cm³) in the packed, ready-to-carry configuration; 150 in³ (2458 cm³) desired.

e. Have a maximum fuel consumption rate of 4oz (.12 liter) per hour when operated at maximum BTU output at sea level.

f. Have a minimum fuel capacity of 10 oz (.30 liter).

g. Be capable of operating at ambient temperatures from -25°F (-30°C) to 125°F (52°C).

h. Be capable of burning the required fuels to an efficiency level which will allow use of the stove in a five or ten-man arctic tent for at least eight hours without harmful effects to the occupants.

i. Be designed to ensure that the stove body and/or case will provide a stable platform for the current canteen cup or a two liter pot.

j. Have an integral carrying case capable of protecting the stove components.

k. Have an integral windscreen. It is desired that the windscreen and carrying case be combined to form one dual purpose item.

l. Have any tool(s) required for routine user maintenance provided as integral components.

m. Be equipped with an integral hand pump to generate initial pressure for operation if a pressurized fuel system is required. Priming or preheating (if required) will be accomplished with same fuel contained in Stove's fuel tank.

n. Have a control mechanism which will allow an evenly graduated adjustment of heat output.

o. Be equipped with an integral mechanism to clean fuel jets and ports.

Enclosure (1)

p. Be designed to minimize the danger of fuel leaks and flareup upon initial lighting regardless of the attitude of the stove.

q. Have an mean-time-between-failure (MTBF) of at least 200 ignitions and 300 hours of operation.

5. OTHER WARFARE AREAS CONCERNED. The introduction of the Lightweight, One-burner Stove will affect Mission Area-216.1 (Combat Service Support; Individual Clothing and Equipment).

6. RELATED EFFORTS. No other Service has a current requirement document in this area.

7. TECHNICAL FEASIBILITY, ENERGY-EFFECTIVENESS IMPACT, AND CCST FORECAST

a. Technical Feasibility. A Lightweight One-burner Stove is technically feasible.

b. Energy-Effectiveness Impact. Not applicable.

c. Cost Estimate. The unit cost of this item is estimated to be \$50 or less; development cost to include safety testing is estimated at \$30,000.

Enclosure (1)

APPENDIX B

U.S. Army Adoption of USMC ROC

FL 13



DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY TRAINING AND DOCTRINE COMMAND
FORT MONROE, VIRGINIA 23651

REPLY TO
ATTENTION OF

ATCD-SE

23 April 1986


SUBJECT: USMC Required Operational Capability (ROC) for the
Lightweight, One-Burner Stove

SEE DISTRIBUTION

1. AR 71-9, 15 Jul 84, Materiel Requirements and Objectives.
2. HQ DA approved, with the changes at Encl 1, the USMC ROC (Encl 2) as an Army requirements document on 31 Mar 86. The following information is applicable to this document:
 - a. System Designation: IPR Program.
 - b. Materiel Developer: AMC.
 - c. Combat Developer: TRADOC.
 - d. Trainer: TRADOC.
 - e. Logistician: USALEA.
 - f. Operational Tester: OTEA.
 - g. CARDS Reference Number: 16004.
3. HQ TRADOC POC is CPT Crosbie, AV 680-3477.

FOR THE COMMANDER:

2 Encls


S. D. SERAFINI
LTC, GS
Chief, Publications and Records
Management Division

DISTRIBUTION:

(Over)

ATCD-SE

23 April 1986

SUBJECT: USMC Required Operational Capability (ROC) for the
Lightweight, One-Burner Stove

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USAREUR & SEVENTH ARMY (AEAGC-FMD) (25)

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CG

MCDEC (D093)

CDR:

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USAAVSCOM, ATTN: AMCPM-ALSE (5)

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DEP CDR, USASSC-NCR, ATTN: ATZI-NPT (2)

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TO: (Forward to proponent of publication or form) (Include ZIP Code) Commander U. S. Army Training and Doctrine Cmd ATTN: ATCD-SE Fort Monroe, VA 23651						FROM: (Activity and location) (Include ZIP Code) HQDA ODCSOPS ATTN: DAMO-FDL Washington, DC 20310-0460	
PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS							
PUBLICATION FORM NUMBER						DATE	TITLE Required Operational Capability (ROC) for the Lightweight, One-Burner Stove
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)	
1	2	4.a	3			<u>COMMENT:</u> Add to end of paragraph, "A warning label describing liquid fuels to be used will be provided in a prominent location on the heater." <u>RATIONALE:</u> Completeness. Users should be deterred from using undesirable fuels in the stove.	
2	2	4.h				<u>COMMENT:</u> Add to end of paragraph, "The stove will provide clean heated air containing a Time-Weighted Average (TWA) of no more than 50 Parts Per Million (PPM) of carbon monoxide, 2 PPM of sulfur dioxide and 3 PPM oxides of nitrogen. The COHb (carboxy-hemoglobin) level in exposed personnel should not exceed 10 percent. The specifications of MIL-HDBK-1472 (para. 5.8.1.2) and the guidance of MIL-HDBK-759A (para 3.7) will be followed." <u>RATIONALE:</u> Completeness. Stove users should be protected from the effects of toxic fumes.	
3	3	4.r				<u>COMMENT:</u> Add paragraph to read, "r. The Lightweight One-Burner Stove shall be capable of meeting applicable human factors engineering criteria of MIL-STD-1472 and MIL-STD-1474 and shall facilitate safe, efficient and effective operation and maintenance by 5-95th percentile user personnel wearing NBC and cold-weather protective clothing (including a 5-finger Army issue leather glove with wool insert), under all anticipated operational conditions." <u>RATIONALE:</u> Completes human engineering requirements IAW AR 602-1.	
*Reference to line numbers within the paragraph or subparagraph							
TYPED NAME, GRADE OR TITLE Edward L. Craig, GM-13				TELEPHONE EXCHANGE/AUTOVON. PLUS EXTENSION AV 225-3261		SIGNATURE <i>Edward L. Craig</i>	

DA FORM 2028
1 FEB 74

REPLACES DA FORM 2028, 1 DEC 68, WHICH WILL BE USED.



DEPARTMENT OF THE NAVY
HEADQUARTERS UNITED STATES MARINE CORPS
WASHINGTON, D.C. 20380

IN REPLY REFER TO
ROC-2-19-avs
4 FEB 1983

From: Commandant of the Marine Corps
To: Distribution List

Subj: Required Operational Capability (ROC) No. LOG 1.62 for
a Lightweight, One-burner Stove

Ref: (a) MCO 3900.4B

Encl: (1) ROC No. LOG 1.62 for a Lightweight, One-burner Stove

1. This letter establishes and promulgates ROC No. LOG 1.62 for a Lightweight, One-Burner Stove. The ROC has been developed in accordance with the reference and is contained in the enclosure.

2. The Commanding General, Marine Corps Development and Education Command (Director, Development Center) is the Marine Corps point of contact for the development efforts pertaining to the Lightweight, One-burner Stove.

Eugene B. Russell
Eugene B. RUSSELL
DEPUTY CHIEF OF STAFF FOR RD&S

DISTRIBUTION LIST:
(See attached)

REQUIRED OPERATIONAL CAPABILITY (ROC) No. LOG 1.62
FOR A
LIGHTWEIGHT, ONE-BURNER STOVE

1. STATEMENT OF THE REQUIREMENT. Marines engaged in combat operations in cold weather environments require a small, lightweight stove to heat rations and water for fire team and squad sized groups. An Initial Operational Capability (IOC) of FY 1987 is required.

2. THREAT AND OPERATIONAL DEFICIENCY

a. Threat. Not applicable.

b. Operational Deficiency. The conversion of tactical vehicles from gasoline to diesel fuel will reduce the availability of gasoline in Marine Air-Ground Task Forces beginning in FY 1985. The Stove, Gasoline Burner, M1950 (Squad Stove) which has been used extensively by Marine Corps units engaged in cold weather operations cannot burn diesel fuel and its design causes it to be marginally stable when used for cooking. This creates a hazard to the occupants of small shelters. The reliability of this stove has also been poor in cold environments. A new stove with a stable, low profile design and capable of burning a variety of fuels would provide a safer and logistically simpler item.

3. OPERATIONAL AND ORGANIZATIONAL CONCEPTS

a. Operational Concept. The Lightweight, One-burner Stove will be used as a cooking and heating unit for groups of from two to five men operating in an isolated or forward area where the use of field mess cooking equipment is not practical.

b. Organizational Concept. The Lightweight, One-burner Stove will be issued as a one-for-one replacement for the Stove, Gasoline Burner, M1950.

c. Training and Support Requirements

(1) No formal specialized training will be required for the user.

(2) The Stove will require user maintenance similar to that required for the replaced item.

(3) Impact on the Marine Corps supply system will be minimal. Development of a small multifuel stove will reduce the types of fuel necessary in an area of operations, thereby simplifying logistic support.

Enclosure (1)

4. ESSENTIAL CHARACTERISTICS. The Lightweight, One-burner Stove will:

- a. Be capable of burning diesel fuel, kerosene, aviation fuel (JP-4/5), or gasoline (leaded or unleaded) efficiently from sea level to 12,000 ft above sea level.
- b. Be capable of producing a minimum of 9000 BTUs at sea level.
- c. Weigh no more than 2 lbs (907g) complete, dry weight; 1.5 lbs (680g) desired.
- d. Have a maximum external volume of 210 in³ (3441 cm³) in the packed, ready-to-carry configuration; 150 in³ (2458 cm³) desired.
- e. Have a maximum fuel consumption rate of 4oz (.12 liter) per hour when operated at maximum BTU output at sea level.
- f. Have a minimum fuel capacity of 10 oz (.30 liter).
- g. Be capable of operating at ambient temperatures from -25°F (-30°C) to 125°F (52°C).
- h. Be capable of burning the required fuels to an efficiency level which will allow use of the stove in a five or ten-man arctic tent for at least eight hours without harmful effects to the occupants.
- i. Be designed to ensure that the stove body and/or case will provide a stable platform for the current canteen cup or a two liter pot.
- j. Have an integral carrying case capable of protecting the stove components.
- k. Have an integral windscreen. It is desired that the windscreen and carrying case be combined to form one dual purpose item.
- l. Have any tool(s) required for routine user maintenance provided as integral components.
- m. Be equipped with an integral hand pump to generate initial pressure for operation if a pressurized fuel system is required. Priming or preheating (if required) will be accomplished with same fuel contained in Stove's fuel tank.
- n. Have a control mechanism which will allow an evenly graduated adjustment of heat output.
- o. Be equipped with an integral mechanism to clean fuel jets and ports.

Enclosure (1)

p. Be designed to minimize the danger of fuel leaks and flareup upon initial lighting regardless of the attitude of the stove.

q. Have an mean-time-between-failure (MTBF) of at least 200 ignitions and 300 hours of operation.

5. OTHER WARFARE AREAS CONCERNED. The introduction of the Lightweight, One-burner Stove will affect Mission Area-216.1 (Combat Service Support; Individual Clothing and Equipment).

6. RELATED EFFORTS. No other Service has a current requirement document in this area.

7. TECHNICAL FEASIBILITY, ENERGY-EFFECTIVENESS IMPACT, AND COST FORECAST

a. Technical Feasibility. A Lightweight One-burner Stove is technically feasible.

b. Energy-Effectiveness Impact. Not applicable.

c. Cost Esitmate. The unit cost of this item is estimated to be \$50 or less; development cost to include safety testing is estimated at \$30,000.

Enclosure (1)

ESTABLISHED COST ASSESSMENT FORMAT
FOR THE
LETTER REQUIREMENT (LR)
MULTI-FUEL INDIVIDUAL/SQUAD STOVE (NISS)

1. Summary of estimated life-cycle costs as expressed in constant FY86 dollars. (\$M-Millions).

	CONSTANT DOLLARS			CURRENT DOLLARS		
	Low	Most Likely	High	Low	Most Likely	High
R&D	0.350	0.389	0.428	0.368	0.409	0.450
Investment	1.991	2.212	2.433	2.526	2.807	3.038
O & S	<u>2.168</u>	<u>2.409</u>	<u>2.650</u>	<u>2.882</u>	<u>3.202</u>	<u>3.522</u>
TOTAL	4.509	5.010	5.511	5.776	6.418	7.050

NOTE 1: Quantity of ED Prototypes - 1,000

NOTE 2: Sunk costs (excluded from Para 1):

R&D	R&D 86
(Actual) \$83,208	(FY86) \$86,869
INVESTMENT	INVESTMENT
(Actual) \$ 0	(FY86) \$ 0

2. Quantity/unit costs, estimated unit/system procurement costs expressed in constant FY86 dollars.

<u>ITEM</u>	<u>QUANTITY</u>	<u>UNIT PROCUREMENT</u>
MISS	50,000	\$43.81

MRDC COST ANALYSIS

KECDC CONTROL NO. 0403851	
VALIDATION LEVEL I	II <input checked="" type="radio"/>
ANALYST <i>Gambian</i>	
SUPERVISOR <i>R. H. [Signature]</i>	
PHONE NO. 4157	
VALIDATION DATE 3 APR 85	
VALIDATION EXPIRATION DATE 3 APR 86	
REMARKS <i>~</i>	

ESTABLISHED COST ASSESSMENT FORMAT
FOR THE
LETTER REQUIREMENT (LR)
MULTI-FUEL INDIVIDUAL/SQUAD STOVE (MISS)
(continued)

3. Recommend Funding Profiles for each applicable appropriation expressed in current (inflated) dollars (\$M-Millions)

	FY85	FY86	FY87	FY88	OYC	TOTAL	
RDT&E:							
Approved	0	0	0	0	0	0	
CON	.049	0.142	0.110	0.088	0	0.388	
CUR	.048	0.146	0.117	0.097	0	0.409	
Variance (CON)	-.049	-0.142	-0.110	-0.088	0	-0.388	
Procurement	FY88	FY89	FY90	FY91	FY92	OYC	
Quantity	500	5000	15000	15000	15000	0	50,000
Approved	0	0	0	0	0	0	0
CON	.022	.219	.657	.657	.657	0	2.212
CUR	.025	.262	.812	.840	.868	0	2.807
Variance (CON)	-.022	-.219	-.657	-.657	-.657	0	-2.212

NOTE 3: Source Document for QTY is FED, FEL, US Army Natick R&D Center.

NOTE 4: Inflation has been incorporated in accordance with DARCOM inflation guidance, issued on 11 January 1985.

APPENDIX C

Safety and Health Data Sheet

SAFETY AND HEALTH DATA SHEET

Item: Multifuel Individual/Squad Stove (MISS)

1. Safety Evaluation Letter/Reports:

- a. Safety Assessment Report, dated 26 August 1987.
 - b. Safety and Health Data Sheet, IPR I/II, dated 25 Aug 87.
 - c. Market Survey of Commercial Camp Stoves Applicable for Military Use, undated.
 - d. Letter Report, Results of FDTE II of the Multifuel/Squad Stove, March 87.
 - e. Final Status Test Incident Report (L3-AL02200), Tropic Test Center, 15 Dec 87.
 - f. Altitude Test Multifuel Individual/Squad Stove, U.S. Army Research Institute of Environmental Medicine, 23 Dec 87.
 - g. Health Hazard Assessment Report, dated 12 January 1988.
 - h. Evaluation of Potential for Diesel Fuel Contamination of One Burner Squad Stove Carrying Case, Material Protection and Biotechnology Branch, Natick, Dated 29 February 1988.
 - i. DT/OT Final Letter Report, Development Test II for the Multifuel Individual/Squad Stove, Cold Regions Test Center, June 1988.
 - j. Independent Assessment Report for the MISS, U.S. Army TECOM, November 1988.
 - k. Independent Evaluation Report for MISS, U.S. Army JFCSWC&S, dated 2 February 1989.
 - l. Final Letter Report, Fix Verification Test of the MISS, U.S. Army CRTC, April 1989.
 - m. Health Hazard Assessment, 4 April 1989, enclosed.
 - n. Memorandum, TECOM, AMSTE-TA-G, 2 June 1989, Subject: Supplement to TECOM Independent Assessment Report of the MISS.
2. The MISS does not contain radioactive materials.
 3. The MISS does not contain explosive/hazardous materials.
 4. The MISS does not contain munitions.

5. An initial Health Hazard Assessment was performed (reference g), and three potential health hazards were identified (see paragraph 7a). After testing was completed a Health Hazard Assessment Report (HHAR) update request was submitted, to which TOSG responded (reference m enclosed): the health hazard issues have been addressed, are included in the TDP, a formal HHAR does not appear to be required, and the referenced document would serve as a HHAR.

6. The MISS is an assemblage of nondevelopmental items. The primary components of the MISS (burner, preheater, and fuel cap) are commercially available and have been safely used on a variety of commercial stoves and lanterns for decades.

7. Summary:

a. Summary of Health Hazard Issues from the USAEHA initial HHAR:

1). Contact with fuels. Soldiers could come in contact with fuel if fuel were to spray from the pressurized tank, or if fuel were to leak from the tank. USAEHA recommended engineering control in the design to minimize contact with fuels, and proper operating instructions/warning labels.

2). Combustion Products. There are many variables that can occur when stoves are used in tents. The size, shape, permeability, and ventilation of the tent; number of soldiers in the tent; number of stoves in the tent; type of fuel used; adjustment of the stove or maintenance condition; amount of time stoves operate; altitude; and environmental conditions such as temperature, wind speed, rain, ice, snow, etc.. In the worse case scenario the likelihood of adverse health effects caused by MISS air pollution is high. USAEHA recommended prohibiting the use of the MISS inside tents or other enclosures.

3). Food/water contamination. A leaking tank could contaminate the case making it unsafe as a pot for handling food and water. USAEHA recommended maintaining and cleaning the MISS case and lid in accordance with the guidance found in TB MED 530 and 577.

b. Summary of test results related to identified HHAR health hazard issues:

(1) Contact with fuels. There were several incidents of fuel leaking from the pressure relief valve on the fuel cap, the gasket seal under the fuel cap, and from cracked fittings on the stove. The design has been improved to correct all three problems, by adding a dirt screen to the relief valve, changing the gasket from nitrile to a fluoro carbon, and by gusseting the tank around the fittings.

(2) Combustion Products. The proponents have deleted the requirement for providing clean heated air for 8 hours in a 5-man arctic tent. Never the less, under adverse weather conditions, soldiers will use the stove in tents even if forbidden to by warning labels. Testing has shown the MISS produces lower levels of hazardous combustion products than the M1950. Testing has also shown that levels of the most dangerous combustion product, carbon monoxide, were well within safe limits. Other combustion products, formaldehyde and sulfur dioxide, reached their highest levels during preheating and then dissipated as the main burner was operated. As long as the stove warning label and the warnings in the Operation and Repair Instructions are observed (Appendix A), the MISS should not present a health hazard with regard to hazardous combustion products.

(3) Food/Water contamination. As mentioned in paragraph (1) above, there were several incidents of material failures which caused fuel contamination of the case. The material failures have been corrected. The guidance of TB MED 530 and MIL-HDBK-740 were followed in preparing the warning label on the stove and warnings in the Operation and Repair Instructions (Appendix A), instructing the stove operator to clean the case thoroughly before using as a cook pot.

c. Summary of other safety and health problems reported during independent testing:

(1) Tank bulging. If the stove was over-pressurized, it would bulge, and become unstable as a cooking platform. When this problem was first identified an attempt was made to correct it by lowering the pressure relief valve setting in the fuel cap from the stock 74 psi, to 25 psi. To insure that fuel would not be vented, the fuel filler neck was designed with an air tube which was suppose to prevent over-filling of the tank. When field tested, the tanks were over-filled regardless, which caused fuel to vent from the fuel cap causing an even greater safety hazard than the fix was suppose to correct. The design has since been modified to restore the fuel cap valve setting to 74 psi and delete the air tube. A separate 25 psi pressure relief valve has been added to the tank, which will eliminate bulging problems.

(2) Fuel Cap Gasket. The fuel filler neck has been designed with a flat spot on the threads to allow pressure to slowly escape from the tank when the cap is unscrewed. It was reported that, during the course of testing, the gasket would sometimes adhere to the filler neck forming a seal that would cause the pressure to be released all at once. To correct this problem the gasket material has been changed from nitrile to a flurocarbon.

(3) Preheating with diesel. The Tropic Test Center reported (reference e) problems associated with difficulties preheating with the local diesel. They experienced severe tank bulging and flareups. However, they conducted their tests on an airport runway where the stoves were exposed to gusting winds. This exposed location was probably not a realistic test condition. The MISS has no trouble burning the Panama diesel (i.e. 4 gallons were burned at Natick in one stove which logged 50 ignitions and 75 hours of operation without difficulty), however, it is recognized that under windy conditions keeping the preheater lit may be difficult. To make preheating with diesel less troublesome, a wick type pilot light has been added to the design.

d. Corrective Actions taken prior to Technical Check Test. All corrective actions detailed in the preceding paragraphs have been incorporated in the MISS tech data package. The Technical Independent Assessor asked for a Technical Check Test to verify the corrections. Twelve stoves were retrofitted with pressure relief valves, dirt screens for the fuel cap, wicks to aid preheating, stronger pump handles, and updated Operation and Repair Instructions. The stoves were sent to the Cold Regions Test Center where they were tested during the months of January and February 1989.

The following technical assessment related to safety and health hazards was taken from the Technical Check Test Final Letter Report.

(1) The design for the pressurization of the fuel tank: The pressurization of the fuel tank was not a problem and has been corrected.

(2) Pressure relief valve: The addition of a new pressure relief valve has eliminated the gross instability associated with the stove bulging reported during last year's testing....

(3) Affixing of labels: The labels, on all stoves, became illegible. The fuel spills as the stove is fueled and causes the lamination to separate from the rest of the stick-on label. This is the same problem encountered last year."

e. Corrective Actions taken following Technical Check Test: The following are provided as a response to the significant problems which were listed in the Final Letter Report for the Technical Check Test described in the preceding paragraph.

"Problem 1.4: Warning labels do not remain legible."

Response: Military standard adhesive backed metal foil labels per MIL-P-19834 have been specified in the drawings. These type of labels are designed to meet severe temperature, abrasion, edge adhesion, aging, and fuel resistance requirements.

f. Summary of safety and health improvements offered by the MISS:

(1) The impingement plate type burner head of the M1950 is likely to produce large yellow flares, soot, incomplete combustion and noxious gases. The vaporizing-type burner head of the MISS provides a soft blue flame, no flares, no soot, reduced noise and little odor. The ability to use any liquid fuel will obviate hazards associated with using incorrect fuels. Heavier fuels (diesel and kerosene) are inherently safer than gasoline.

(2) At low temperatures, the M1950 is difficult to preheat and prone to spraying raw fuel over itself and the immediate area. At low temperatures, the MISS has the same operational characteristics as at room and high temperatures, provided the fuel has not jelled.

(3) The grill of the M1950 is not compatible with the standard canteen cup. The case configuration is not optimal for heating MREs. The grill of the MISS is compatible with the canteen cup. The case functions as an ideal container for heating 6 to 8 MREs, and melting snow (2 quart capacity), provided that it is properly cleaned.

(4) The high profile of the M1950 is unstable and subject to accidental tipping and spills. The MISS is configured with a lower, more stable profile (i.e. 30% lower, 100% larger base).

(5) The MISS has two pressure relief valves. One mounted behind the preheater opens at 25 psi (closes at 20 psi) to prevent over pressurization with the air pump, and one integral with the fuel cap set to open at 74 psi as a back-up to prevent catastrophic failure (tank rupture).

(6) The MISS produces significantly lower levels of hazardous combustion products than the M1950. Preheating generally determines air quality (i.e. a successful preheat will not pollute the air, a less than successful preheat may pollute the air with sulfur dioxide and formaldehyde for a short period of time). Carbon monoxide was never a danger with the MISS. Kerosene is the safest fuel to use in confined areas with poor ventilation.

8. Conclusions. The Multifuel Individual/Squad Stove is considered safe to use provided the operation and maintenance instructions are followed and the warning labels are observed. The MISS is recommended for type classification.

Frederick J. ...
Emm Oakard 6/29/89

Patrick J. Kelly 29 June 1989

Paul S. ... 29 June 1989

APPENDIX A

Warnings from "MISS Operation and Repair Instructions"

1. Do not use the stove without adequate ventilation. Liquid fueled stoves produce hazardous by-products of combustion and will consume available oxygen within an enclosure.

DO NOT USE THE STOVE FOR TENT HEATING

2. Gasoline, Coleman, and Blazo fuels are far too hazardous to be used in confined spaces. Spilled fuel will readily ignite. Vapor when mixed with the correct proportion of air is explosive.

3. Kerosene is the safest fuel to use. If you have no choice but to use the stove in a tent, plan to use clean kerosene, provide plenty of ventilation, and let the stove preheat in a door-way or outside the tent.

4. Clean the case thoroughly before using for cooking. Detergent works best. Sand or snow is also effective for scouring the oil film. The case is clean enough when you can no longer smell fuel.

5. Practice using the stove before a field trip. Practice and familiarization with the stove will improve the ease with which you can use the stove under adverse conditions.

6. Release pressure in the tank packing and storing to avoid accidental leakage and possible ignition of fuel-soaked clothing, sleeping bags, etc.

Warnings shown on warning label:

WARNING

1. All liquid fuel stoves are potentially hazardous due to the flammability of the fuels and the fumes produced.

DO NOT USE STOVE FOR TENT HEATING

2. If you have no choice but to use the stove in a tent, use it only for food and water heating and provide ample ventilation.

3. Stove can burn gasoline, kerosene, JP 4/5/8, and diesel. Use air restrictor tube stored in pump when burning gasoline and JP4. Use of leaded gas in unventilated spaces may be a health hazard.

4. Clean case thoroughly before using as a pot. Use detergent and hot water. It is clean when you can no longer smell fuel.

AMCSG (STRNC-ZSR/8 Feb 89) (70-1f) 1st End MAJ(P) Wolfe/AUTOVON 284-8975
SUBJECT: Final Health Hazard Assessment on the Multi-fuel Individual Squad
Stove (MISS)

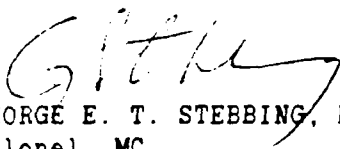
Cdr. USAMC, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001 4 April 1989

FOR Commander, U.S. Army Natick Research, Development and Engineering Center,
ATTN: STRNC-ZSR, Natick, MA 01760-5000

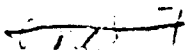
1. Reference Memorandum, HQ NRDEC, STRNC-WSA, 24 Sep 87, Subject: Initial Health Hazard Assessment on the Multi-fuel Individual Squad Stove.
2. The AMC Surgeon's Office has reviewed the request and the supporting documents for the MISS. Based upon this review, this office concludes that the health hazard issues identified by the above reference have been addressed and are included in the MISS Tech Data Package. A formal health hazard assessment report (HHAR) does not appear to be required at this time, and this document may serve as the HHAR. Provide the results of the Technical Check Test from the Cold Region Test Center for a final verification.
3. Point of contact for the headquarters is MAJ(P) H. E. Wolfe, Health Hazard Assessment Officer, AMODE-XS, AUTOVON 284-8975.

FOR THE COMMANDER:

Encl
wd


GEORGE E. T. STEBBING, M.D.
Colonel, MC
Command Surgeon

CF (wo/encl):
SGPS-PSP-E
HSHB-MO-A
HSCL-P
HSHA-CDM
SGRD-PLC
TRADOC, ATMD
FORSCOM, FCMD
AMODE-S
AMCSF-E
SLCHE-DA

Encl 1


RECORD OF ENVIRONMENTAL CONSIDERATION

Title: Type Classification of the Multifuel Individual/Squad Stove

Description of Proposed Action: See title above.

Anticipated date: 30 Jun 89.

It has been determined that the action qualifies for Categorical Exclusion #28, Appendix A, AR 200-2, and no extraordinary circumstances exist as defined in paragraph 4-3, AR 200-2.

Signed:

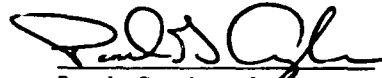


Donald W. Pick
Project Engineer, MISS
AEB, TAD, FED

Date:

6/29/89

Concurrence:



Paul G. Angelis
Program Environmental
Coordinator

Date:

29 June 1989

APPENDIX D

Supplement to TECOM Independent Assessment Report of the Multifuel Individual/Squad Stove



DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005-5005



REPLY TO
ATTENTION OF

AMSTE-TA-G (70-10p)

2 June 1989

MEMORANDUM FOR Commander, U.S. Army Natick Research, Development and
Engineering Center, ATTN: STRNC-EPT/STRNC-WAE,
Natick, MA 01760

SUBJECT: Supplement to TECOM Independent Assessment Report of the Multi-Fuel
Individual/Squad Stove (MISS)

1. References:

a. Independent Assessment Report for the Multi-Fuel Individual/Squad
Stove (MISS), TECOM, 8 November 1988.

b. Final Letter Report Fix Verification Test (E2G) of the Multi-Fuel
Individual/Squad Stove, USACRTC, April 1989.

c. Memorandum, NRDEC, STRNC-WAE, 13 February 1989, subject: Test of
Multifuel Individual/Squad Stove on Panama Diesel.

d. Memorandum, NRDEC, STRNC-WAE, 13 February 1989, subject: Fix
Verification Test Report and TECOM Assessment Report of the Multifuel
Individual/Squad Stove.

2. Background. The MISS was tested at U.S. Army Cold Regions Test Center
(USACRTC) and U.S. Army Tropic Test Center (USATTC) during the spring of 1988.
TECOM's IAR (Reference 1a) stated that the MISS was not ready to be type
classified, because of safety deficiencies and reliability problems uncovered
during the testing. The MISS was modified and a recheck test was conducted
at USACRTC from January through March 1989 (Reference 1b). The MISS will be
procured by Defense Logistics Agency.

3. Objective. The objective of this supplemental IAR is to provide a basis
for the decision body to determine whether the MISS should be type classified.

4. Assessment. Twelve MISS were modified and sent to USACRTC. The modifica-
tions included: a stronger pump handle, a separate relief valve, a dirt
filter for the fuel cap, a wick for the preheater pilot light, and an updated
operation and repair sheet. Testing at USACRTC revealed the following:

a. Performance. The performance issue is considered met even though the
MISS did not meet the 4000-BTU requirement for each fuel and did not have an
integral windscreen. The BTUs generated by the modified stove were lower than
that of the original MISS tested. This was thought to be caused by lower
pressure in the fuel tank because the pump had a shorter stroke. Even though
the MISS does not meet the requirement at -25 degrees F, it does provide more
heat than the standard item (M1950) and was sufficient to heat Meal, Ready to
Eat (MRE) as shown in Table 1. The MISS was capable of burning all the fuels
listed below as well as JP5 and diesel fuel (F76). JP5 fuel was difficult to

AMSTE-TA-G

SUBJECT: Supplement to TECOM Independent Assessment Report of the Multi-Fuel Individual/Squad Stove (MISS)

light; it tends to quickly coat the main burner with carbon, thus more frequent cleaning of the MISS is required. It is suggested that JP5 be used as a last choice.

Table 1. MISS BTU Output

<u>Fuel Type</u>	<u>Avg. BTU Output/Hour MISS/M1950</u>
White Gas	5188/2097
Unleaded Gas	3606
Leaded Gas	4288
Diesel Gas Arctic	3517
JP4	3322
JP8	3633
Kerosene	4048

b. Compatibility. The compatibility issue is considered met since the MISS is now compatible with all necessary equipment including the pot and standard canteen cup. The gross instability was eliminated by a new pressure relief valve which substantially reduced the bulging of the fuel tank.

c. Safety. The safety and health hazards associated with the MISS can be considered eliminated or controlled within acceptable levels with proper warning about operation/use and transportation. Implementation of changes necessary to correct/control assessed safety problems is considered low risk.

(1) The fuel cap did not leak; however, transportation by rucksack was not conducted. The safety deficiency assessed in the previous IAR (Reference 1a) because fuel leaked through the cap while the MISS was being transported in rucksacks is still an open issue. Until data are available to verify correction of this transportation problem, the MISS must be empty of fuel when transported within a rucksack. This safety deficiency can be controlled to acceptable levels by including a warning in the manuals about this potential hazard.

(2) The pressure release valve deficiency assessed in the previous IAR (Reference 1a) is considered controlled within acceptable levels through the addition of a pressure relief valve to the rear of the preheater. The addition of this valve substantially reduced the bulging of the fuel tank. Because the MISS still bulged slightly, the rim at the base of the tank should be thickened, as stated in Reference 1d, to further improve the stability of the MISS.

(3) No test data were collected at USACRTC using heavy grade fuels such as the one previously used at USATTC (i.e., F76 diesel fuel). However, data collected at NRDEC (Reference 1c), under laboratory conditions, indicate no observable differences in the performance of the stove when operated with either the DF2 diesel fuel available at NRDEC or the F76 diesel fuel obtained from USATTC. The NRDEC analysis of the fire hazard associated with F76 diesel

AMSTE-TA-G

SUBJECT: Supplement to TECOM Independent Assessment Report of the Multi-Fuel Individual/Squad Stove (MISS)

fuel indicates that the principal cause for the safety deficiency previously experienced at USATTC was not the fuel, but rather the windy conditions at the test site. A wick has been added to the stove to help alleviate the problems with wind and fuel contaminants. In addition to the design changes, specific instructions about the fire hazard involved when operating the MISS in windy conditions and with contaminated fuels must be included in the MISS manual. Failure to include such warnings in the manual could result in user personnel being exposed to a critical burn hazard.

(4) Soldiers who tested the MISS determined that the wick provided at the end of the control knob was inadequate. After being used to light the preheater, the wick remained impregnated with fuel. Then, while using the control knob to adjust the main burner, the preheater could reignite the impregnated wick at the other end of the knob. NRDEC, in their analysis (Reference 1d) of the test data, indicated that the wick must be left under the preheater to function as a pilot light. If this is done, the fuel on the wick would be consumed and it would not be possible to relight the wick when adjusting the main burner. Assessment of USACRTC test data and NRDEC information indicated that instructions provided for the use of the wick are inadequate. The identified safety problem (uncontrolled relighting of the wick) will be considered controlled within acceptable levels by posting specific instructions in the manual on the use of the wick.

(5) Fuel leaks were caused by the failure of MISS components (e.g., tank seams, cracked fuel filter necks, and broken valve spindle teeth). Test participants indicated that the MISS was safe to operate even though five minor flare-up incidents were reported during testing. Reported flare-ups were attributed to the stove not being wiped dry of spilled fuel. It is suggested that a warning be included in the MISS manual instructing soldiers to check for leaks and to wipe any fuel off the surface of the stove before lighting. Failure to add such warning to the MISS instructions will be considered a critical remote safety hazard (RAC II-D), a shortcoming.

(6) The stick-on safety instruction labels were not durable. The problem with the MISS warning labels (illegibility, peeling) is reassessed as a marginal occasional safety hazard (RAC III-C), a shortcoming. This safety hazard is considered controlled since Reference 1d states that military standard, adhesive-backed, foil labels per MIL-P-19834 have been specified in the drawings.

d. Human Factors. Overall troop acceptability of the stove was good; however, three human factors concerns were reported. The preheater and the burner were rated as "difficult" to use in windy conditions. A soldier must find some way to block the wind to start the stove. The pump-to-stove attachment was flimsy and was rated as "not quite adequate." The stove labels were a recurring problem. Fuel spills caused the warning and caution labels and the operating instructions to become illegible.

e. Reliability. The MISS did not meet the reliability requirements. The lower 90 percent confidence limits of mean-time-between-failures (MTBF)

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(60.8 hours) and mean-ignitions-between-failures (MIBF) (75 ignitions) are lower than the requirements of 120 hours and 120 ignitions. However, both the demonstrated MTBF and MIBF values are higher than those demonstrated during the Production Prove-Out test. The MISS has the potential of meeting its reliability requirements, if the corrections stated below in section 4e(1) are completed.

(1) Ten stoves were used between 15 and 152 hours and attained between 40 and 182 ignitions, accumulating a total of 1,152 hours of use and 1,420 ignitions. There were 13 operational mission failures (OMFs) scored against the MISS. A summary of OMFs by failed component is presented in Table 2. The tester suggested that the spacer of the pump should be crimped tightly to prevent any movement of the spacer and the spindle teeth of the valve should be hardened. (Reference 1d states that these changes have been added to the drawings.) The logistic concept should be modified to include replacement of the pressure relief valves, preheaters, and jet stoppers at the organizational level.

Table 2. Operational Mission Failures by Component

<u>Failed Component</u>	<u>No. of Failures</u>	<u>Description of Failure</u>
Fuel Tank	2	Fuel leak at seam weld
Fuel Tank	1	Crack in fuel filter neck
Pump	3	Pump handle spacer moved
Preheater	3	Preheater replacement
Valve Spindle	2	Broken tooth on spindle
Jet stopper	1	Jet stopper replaced
Pressure Relief Valve	1	Valve not functioning

(2) The Kolmogorov-Smirnov goodness-of-fit test indicated that the assumption of the failure data being exponentially distributed cannot be rejected. The point estimate of MTBF is 88.6 hours with lower 90 percent confidence limit of 60.8 hours. The point estimate of MIBF is 109 ignitions with lower 90 percent confidence limit of 75 ignitions.

f. Logistic Supportability. The ILS of the MISS is not adequately developed. The same problems that occurred during the Production Prove-Out test (technical publications, supply support, and support concept problems) occurred in this test.

(1) The instruction booklet contained many errors including incorrect instructions on the replacement of the jet needle. The booklet does not have a Maintenance Allocation Chart. The stick-on safety instruction labels were not durable after 90 burn hours (after that time the labels began to delaminate in the area near the fuel cap). The label problem will be resolved since Reference 1d states labels per MIL-P-19834 have been specified. The manuals must be improved and completed before fielding.

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(2) The supply support was not adequate for the MISS, since it did not contain an eraser to help in replacing the jet needle. Also, a small, flat-tip screwdriver needed to replace the nozzle stopper on the preheater was not provided. These two items should be included in the operator's repair kit.

(3) Organizational maintenance was not included in the initial logistic concept. It is suggested that the spare parts that are not permanently affixed to the stove be provided at the organizational level; i.e., pump, funnel, case, fuel caps, and wrenches.

g. Environment. This issue is considered met since it was shown that the MISS could be safely lighted with diesel (F76) fuel. The MISS operated in temperatures down to -25 degrees F.

5. Conclusion. The conclusions of the previous assessment are superseded by the following:

Based on the data and analysis to date, the modified MISS is ready to be type classified.

6. Recommendations. Based on the modifications of the MISS, the recommendations of the previous assessment are superseded by the following:

6.1 Add safety warnings to the manuals.


6.2 Ensure all procurement documentation are updated to reflect corrections listed in Reference 1d.

6.3 Improve the MISS technical publications and supply support.

6.4 Ensure provisioning includes organizational stockage of preheaters, jet stoppers, pressure relief valves, pumps, funnels, cases, fuel caps, and wrenches.

7. The points of contact at this headquarters are Mrs. Nancy H. Dunn, AMSTE-TA-G, amstetag@apg-emhl.apg.army.mil, AUTOVON 298-5221/5222 and MAJ Ralph Perrino, AMSTE-TA-T, amstetat@apg-emhl.apg.army.mil, AUTOVON 298-3640/3766.

FOR THE COMMANDER:


HARRY J. PETERS
Technical Director

APPENDIX E

Military Specification: Stove, Multifuel Squad

INCH-POUND

MIL-S-44344
28 June 1989

MILITARY SPECIFICATION

STOVE, MULTIFUEL SQUAD

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements including drawings for the multifuel squad stove, with case, which will be used for groups of 2 to 5 personnel engaged in combat operations. The stove has been designed to burn any available liquid fuel including diesel, kerosene, JP 4/5/8 and gasoline (see 6.1).

2. APPLICABLE DOCUMENTS

2.1 Government documents

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. Army Natick Research, Development, and Engineering Center, Natick, MA 01760-5014 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 7310

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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SPECIFICATIONS

FEDERAL

- L-P-378 - Plastic, Sheet and Strip, Thin Gauge, Polyolefin
- VV-F-800 - Fuel Oil, Diesel
- PPP-B-601 - Boxes, Wood, Cleated-Plywood
- PPP-B-636 - Boxes, Shipping, Fiberboard

MILITARY

- MIL-T-704 - Treatment and Painting of Material

STANDARDS

MILITARY

- MIL-STD-105 - Sampling Procedures and Tables for Inspection
by Attributes
- MIL-STD-129 - Marking for Shipment and Storage
- MIL-STD-147 - Palletized Unit Loads
- MIL-STD-731 - Quality Of Wood for Containers and Pallets
- MIL-STD-970 - Standards and Specifications, Order of Preference for
the Selection of

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DRAWINGS

U.S. ARMY NATICK RESEARCH, DEVELOPMENT, AND ENGINEERING CENTER

- 6-1-8823 - Stove Assembly, Multifuel, Squad; with Case
- 6-1-8825 - Case
- 6-1-8826 - Lid
- 6-1-8827 - Stove Assembly
- 6-1-8828 - Pump Assembly
- 6-1-8829 - Cylinder, Pump
- 6-1-8834 - Handle
- 6-1-8840 - Wrench

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- 6-1-8842 - Hook, Retaining
- 6-1-8843 - Tank Assembly
- 6-1-8848 - Preheater Assembly
- 6-1-8849 - Fuel Cap Assembly
- 6-1-8850 - Labels, Identification and Instruction

(Copies of drawings are available from the U.S. Army Natick Research, Development, and Engineering Center, ATTN: STRNC-EMSS, Natick, MA 01760-5014.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 3951 - Standard Practice for Commercial Packaging

(Applications for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

(Non-Government standards and other publications are normally available from organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.3), in accordance with 4.3.

3.2 Materials and components. The materials and components shall be as specified herein and on the applicable drawings. Materials and components not specified shall be selected by the contractor in accordance with MIL-STD-970. Materials and components specified in accordance with MIL-STD-970 shall not degrade the operational suitability or effectiveness of the stove. It is encouraged that recycled material be used when practical providing the requirements of the specification are met.

3.3 Design and construction. The design and construction shall be as specified herein and as shown on Drawing 6-1-8823 and all subsidiary drawings and parts lists pertaining thereto.

3.4 Performance.

3.4.1 Tank leakage. Prior to attachment of grill and finishing, the tank shall not leak when tested as specified in 4.5.2.

3.4.2 Stove assembly leakage. The stove assembly shall not leak when tested as specified in 4.4.5.

3.4.3 Tank capacity. The tank shall hold 10 ounces minimum and 10.5 ounces maximum of fuel when tested as specified in 4.4.5.

3.4.4 Stove operation and performance. When tested as specified in 4.4.5, the stove shall meet the following requirements.

3.4.4.1 Preheater. The preheater shall light on the first attempt while using only one match and require no more than one additional match to re-light during the time required to preheat.

3.4.4.2 Burner.

3.4.4.2.1 Control knob rotation. The control knob (valve spindle) shall rotate $135 \pm 22.5^\circ$ before and after the lighting test.

3.4.4.2.2 Burner ignition. The burner shall light automatically from the flame of the preheater.

3.4.4.2.3 Burner flame. With the control knob fully open, the flame shall be symmetrical and blue around the entire outer cap with no traces of yellow and shall heat the two uppermost bars of the grill equally resulting in equal red patterns. With the control knob partially open, the heating shall be symmetrical with the outer cap becoming red uniformly all around. (NOTE: Partially open is the amount required for the outer cap to be heated to a red glow.)

3.4.4.2.4 Valve spindle leakage. There shall be no flame or vapor leaking around the valve spindle.

3.4.4.2.5 Residual fuel. When the stove is operated with the control knob fully open and allowed to run out of fuel, there shall be no more than .5 ounces of unconsumed fuel in the tank.

3.4.5 Pressure relief valve. The pressure relief valve shall open at no more than 25 PSIG and close at no less than 20 PSIG when tested as specified in 4.4.5.

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3.5 Labels. The labels shall conform to Drawing 6-1-8850. The contents of the labels shall be clearly legible and shall be firmly affixed to the stove in the required locations with no areas of poor or no adhesion. The labels shall be free of tears and scratches.

3.6 Workmanship. The stove assembly shall conform to the quality of product established by this specification.

3.6.1 Surface Defects. The stove assembly shall be free from fractures, splits, punctures, dents, creases and bows. There shall be no burrs, slivers, sharp edges or sharp corners.

3.6.2 Welds. The surfaces of parts to be welded shall be free from oxide, scale, paint, grease and other foreign matter. Welds shall be sound, continuous, smooth and free from pits, burn holes, cracks, fissures, incomplete fusion and deformation of material. All scale, flux deposits and excess metal shall be removed from the finished welds. The welds shall be finished to blend smoothly with the adjacent surfaces.

3.6.3 Brazing. The surface of parts to be brazed shall be free from oxide, scale, paint, grease and other foreign matter. Brazing shall be smooth, continuous, sound and free of embedded foreign matter. All flux shall be removed.

3.6.4 Threaded fittings. Threads shall not be missing, broken, stripped or fractured. Threads shall be protected during welding, brazing, cleaning and painting from being distorted, damaged or coated. When a thread sealing compound is required, it shall be applied uniformly on all threads and any excess after tightening shall be removed.

3.6.5 Finishing. Coatings shall level out to an adherent, continuous and uniform film without runs, streaks, embedded foreign material or areas of no film. The finish after baking shall be free of blistering, crinkling, peeling or chipping.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Responsibility for dimensional requirements. Unless otherwise specified in the contract or purchase order, the contractor is responsible for ensuring that all specified dimensions have been met. When dimensions cannot be examined on the end item, inspection shall be made at any point, or at all points in the manufacturing process necessary to assure compliance with all dimensional requirements.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. First article inspection (see 4.3)
- b. Quality conformance inspection (see 4.4)

4.3 First article inspection. When a first article is required (see 3.1 and 6. 2), it shall be examined for the defects specified in 4.4.3 and 4.4.4 and tested for the characteristics specified in 4.4.5.

4.4 Quality conformance inspection. Unless otherwise specified, sampling for inspection shall be performed in accordance with MIL-STD-105.

4.4.1 Component and material inspection. In accordance with 4.1, components and materials shall be inspected in accordance with all the requirements of referenced documents unless otherwise excluded, amended, modified, or qualified in this specification or applicable purchase document.

4.4.2 In-process inspection. Inspection of subassemblies shall be made to ascertain that construction details which cannot be examined in the finished product are in accordance with specified requirements. The Government reserves the right to exclude from consideration for acceptance, any material or service for which in-process inspection has indicated nonconformance.

4.4.2.1 Visual examination of operations. Inspection shall be made of the following operations to establish conformance to specified requirements.

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Whenever nonconformance is noted, correction shall be made to the items affected and to the operation. Items which cannot be corrected shall be removed from production.

- a. Welding and brazing of tank conforms to 3.6.2, 3.6.3 and Drawing 6-1-8843.
- b. Application of sealing compound to threads conforms to 3.6.4 and Drawings 6-1-8827, 6-1-8848 and 6-1-8849.
- c. Cleaning and priming of components prior to final coat of paint conforms to MIL-T-704.
- d. Temperature of oven and time period for baking final finish coat conforms to Drawings 6-1-8829, 6-1-8834, 6-1-8840, 6-1-8842 and 6-1-8843.
- e. Gasket used when installing preheater assembly to tank in compliance with Drawing 6-1-8827.
- f. Siphon tube on preheater assembly is orientated vertically into tank when trigger is orientated in specified position in compliance with Drawings 6-1-8827 and 6-1-8848.
- g. Filters are properly rolled and installed in burner assembly fitting in compliance with Drawing 6-1-8827.
- h. O-Ring is installed on gland in pump in compliance with Drawing 6-1-8828.
- i. Fittings are protected from being distorted during brazing and welding in compliance with 3.6.4 and Drawing 6-1-8843.

4.4.3 End item visual examination. The end items shall be examined for the defects listed in table I. The lot size shall be expressed in units of stoves. The sample unit shall be one stove. The inspection level shall be II (see 6.5).

TABLE I. End item visual defects

Examine	Defect	Classification	
		Major	Minor
Finish	Blistered, crinkled, peeling, chipping, or not adherent	101	
	Permanently stained, tacky, uncoated areas, runs, streaks or embedded foreign matter	102	
	Color not as specified	103	

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TABLE I. End item visual defects (cont'd)

Examine	Defect	Classification	
		Major	Minor
Welding	Any weld missing, incomplete, cracked, fractured, has burn holes or fusion incomplete	104	
	Not smooth, scale or flux deposits, excess metal not removed		201
Brazing	Any Braze missing, not smooth or not continuous	105	
	Flux not removed		202
Threaded components	Threads broken, stripped, fractured or missing	106	
	Components not securely tightened		203
	Excess sealing compound not removed		204
Design, construction and workmanship (applicable to all components and assemblies)	Any component missing or not as specified	107	
	Fractured, split, punctured torn, dented, creased, bowed or otherwise malformed	108	
	Any component misplaced or not in proper alignment		205
	Any burr, sliver or sharp edge		206
	Any loose particles inside tank (as noted when shaking)		207
	Any operation omitted or not performed as specified	109	
	Any functioning component that is inoperative or will not operate as intended	110	
	Lid does not fit on case or does not fit snugly on case	111	
Lanyards, wrench and funnel	Chain improperly attached		208
Labels	Any missing, incorrect, incomplete, scratched, torn, not legible or not in proper location	112	
	Any area not securely adhered to tank		209

TABLE I. End item visual defects (cont'd)

Examine	Defect	Classification	
		Major	Minor
Instruction sheet or not legible	Missing, incorrect, incomplete,	210	

4.4.4 End item dimensional examination. The end items shall be examined for conformance to the dimensions specified on Drawings 6-1-8825, 6-1-8826, 6-1-8827 and 6-1-8843 that are annotated with an asterisk (see 4.1.2). Any dimension not within the specified tolerance shall be classified as a defect. The lot size shall be expressed in units of stoves. The sample unit shall be one stove. The inspection level shall be S-3 (see 6.5).

4.4.5 End item testing. The stoves shall be tested for the characteristics listed in table II. The lot size for all tests shall be expressed in units of stoves. The sample unit shall be one stove. The inspection level for stove leakage and the stove operation and performance tests shall be II and for all other tests, S-2 (see 6.5).

TABLE II. End item tests

Characteristic	Specification reference		Number determinations per sample unit	Results reported as
	Require- ment	Test method		Pass or Fail
Stove leakage	3.4.2	4.5.3	1	X
Tank capacity	3.4.3	4.5.4	1	X
Stove operation and performance	3.4.4	4.5.1	8	X
Pressure relief valve performance	3.4.5	4.5.3	1	X

4.4.6 Packaging examination. The fully packaged end items shall be examined for the defects listed below. The lot size shall be expressed in units of shipping containers. The sample unit shall be one shipping container fully packaged. The inspection level shall be S-2 (see 6.5).

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<u>Examine</u>	<u>Defect</u>
Marking (exterior and interior)	Omitted; incorrect; illegible; of improper size, location, sequence, or method of application
Materials	Any component missing, damaged, or not as specified
Workmanship	Inadequate application of components, such as: incomplete sealing or closure of flap, improper taping, loose strapping or inadequate stapling Bulged or distorted container
Content	Number per container is more or less than required

4.4.7 Palletization examination. The fully packaged and palletized end items shall be examined for the defects listed below. The lot size shall be expressed in units of palletized unit loads. The sample unit shall be one palletized unit load, fully packaged. The inspection level shall be S-1 (see 6.5).

<u>Examine</u>	<u>Defect</u>
Finished dimensions	Length, width, or height exceeds specified maximum requirements
Palletization	Pallet pattern not as specified Interlocking of loads not as specified Load not bonded as specified
Weight	Exceeds maximum load limits
Marking	Omitted; incorrect; illegible; of improper size, location, sequence, or method of application

4.5 Methods of inspection.

4.5.1 Stove operation and performance tests. The stove operation and performance tests shall be performed as specified below. Pressurizing and lighting of stove shall be in accordance with the instructions on the instruction label.

Fill tank with summer grade diesel fuel conforming to grade DF-2 of VV-F-800 and pressurize tank.

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b. With burner control knob in full off position (rotate clockwise to shut off) rotate to full open position and measure amount of rotation. Failure to meet requirement in 3.4.4.2.1 shall constitute failure of the test. Return control knob to off position.

c. Light preheater. Failure to be able to light the preheater with a single match or relight using one additional match as specified in 3.4.4.1 shall constitute failure of the test.

d. Light burner and observe performance with control knob in the full open position and the partial open position. Failure to provide the flame and heating required as specified in 3.4.4.2.3 shall constitute failure of the test.

e. During the burner performance test, inspect for flame or vapor leakage around the valve spindle. If there is any flame or vapor leakage, tighten the valve spindle nut and let the stove burn for an additional five minutes minimum and again inspect for flame or vapor leakage around the valve spindle. Failure to meet the requirements in 3.4.4.2.4 for no leakage shall constitute failure of the test.

f. Operate the stove until the flame dies out. Shut burner off and repeat control knob rotation test required in b. above.

g. Drain completely and measure the residual fuel in the tank. Any fuel in excess of the amount specified in 3.4.4.2.5 shall constitute failure of the test.

4.5.2 Tank leakage test. The burner, preheater, and safety relief valve fittings in the unfinished tank shall be securely capped and the fuel cap shall be securely closed. An air pressure of 30 ± 2 PSIG shall be applied and maintained through the fuel cap. Submerge the tank completely in clear water maintained at room temperature ($70^\circ \pm 2^\circ\text{F}$) for a minimum of 30 seconds. In accordance with 3.4.1, any steady stream of air bubbles shall be considered evidence of leakage and failure of the test. Any test failure shall be cause for rejection of the tank and correction of the affected process. Successfully tested tanks shall be fully dried prior to being put back into the production lot.

4.5.3 Pressure relief valve performance and stove assembly leakage tests. With the tank empty, the burner assembly, preheater trigger and fuel cap shall be securely closed. A pressure gauge and a means of pressurizing the stove shall be attached to the fuel cap. Submerge the stove (without pump) completely in clear water maintained at room temperature ($70 \pm 2^\circ\text{F}$) for a minimum of 30 seconds. An air pressure of not less than 25 PSIG shall be applied through the fuel cap. A steady stream of bubbles should be released from the pressure relief valve. Slowly allow the pressure to reduce and observe when bubbles are no longer being emitted from the relief valve. There should be no bubbles being emitted when the pressure drops to 20 PSIG. In accordance with 3.4.5 if there

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are no bubbles being emitted at a pressure of 25 PSIG or there are bubbles being emitted at a pressure of 20 PSIG, the test shall be considered a failure. In accordance with 3.4.2, any steady stream of air bubbles (except coming from the pressure relief valve) shall be considered evidence of stove leakage and failure of the leakage test. Successfully tested stoves shall be fully dried prior to being put back into the production lot.

4.5.4 Tank capacity test. Assure that the tank is empty. Securely close the burner valve and preheater trigger and place stove on a level surface. Measure out 10.5 ounces of any one of the fuels used in the stove. The fuel shall be at room temperature ($70 \pm 2^{\circ}\text{F}$). Using the stove funnel, pour the fuel into the tank. The tank is full when the fuel level reaches the top of the filler fitting. In accordance with 3.4.3, if the tank is not full or if there is more than .5 ounces of residual fuel, the test shall be considered a failure.

5. PACKAGING

5.1 Preservation. Preservation shall be level A or Commercial, as specified (see 6.2).

5.1.1 Level A preservation. Each stove, before being placed in its case, shall be packaged in a clear polyethylene film bag of 0.004 inch thickness conforming to type I, class 2 of L-P-378. The bag shall be of adequate size to completely enclose the stove and prevent movement and abrasion within its case. Each complete stove and case shall be placed in a snug-fitting intermediate box conforming to style RSC, type CF (variety SW), class domestic, grade 200 of PPP-B-636. Inside dimensions shall approximate 7-1/8 inches in length, 4-5/8 inches in width, and 5-3/8 inches in depth. Approximate dimensions are furnished as a guide only. Each intermediate box shall be closed in accordance with method II as specified in the appendix of PPP-B-636.

5.1.2 Commercial preservation. Each stove with case shall be preserved in accordance with ASTM D 3951.

5.2 Packing. Packing shall be level A, B, or Commercial, as specified (see 6. 2).

5.2.1 Level A packing. Twenty-four stoves with cases, preserved as specified in 5.1, shall be packed in a snug-fitting shipping container conforming to overseas type, style A or J, grade A, type 2 load of PPP-B-601. Level A intermediate boxes shall be packed upright, three in length, four in width and two in depth within a shipping container. Inside dimensions of each container shall approximate 23 inches in length, 20-1/2 inches in width and 12 inches in depth. Approximate dimensions are furnished as a guide only. Each shipping container shall be closed and reinforced in accordance with the appendix of PPP-B-601.

5.2.2 Level B packing. Twenty-four stoves with cases, preserved as specified in 5.1, shall be packed in a snug-fitting shipping container conforming to style RSC, grade V3c, V3s or V4s of PPP-B-636. Level A intermediate boxes shall be packed upright, three in length, four in width and two in depth within a shipping container. Inside dimensions of each container shall approximate 23 inches in length, 20-1/2 inches in width and 12 inches in depth. Approximate dimensions are furnished as a guide only. Each shipping container shall be closed in accordance with method III as specified in the appendix of PPP-B-636.

5.2.3 Commercial packing. Stoves with cases, preserved as specified in 5.1, shall be packed in accordance with ASTM D 3951.

5.3 Palletization. When specified (see 6.2), stoves with cases, packed as specified in 5.2, shall be palletized on a 4-way entry pallet in accordance with load type I or Ia of MIL-STD-147, as applicable. Pallet types shall be type I (4-way entry), type IV or type V in accordance with MIL-STD-147. Pallets shall be fabricated from wood groups I, II, III, or IV of MIL-STD-731. Each prepared load shall be bonded with primary and secondary straps in accordance with bonding means K and L or film bonding means O or P. Pallet pattern shall be number 90 in accordance with the appendix of MIL-STD-147. Interlocking of loads shall be effected by reversing the pattern of each course.

5.4 Marking. In addition to any special marking required by the contract or purchase or order, intermediate boxes, shipping containers and palletized unit loads shall be marked in accordance with MIL-STD-129 or ASTM D 3951, as applicable.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The stove covered by this specification is intended for use in the field for cooking rations, heating water and melting snow for groups of 2 to 5 personnel.

6.2 Ordering data. Acquisition documents must specify the following:

- a. Title, number and date of this specification.
- b. Issue of DODISS to be cited in the solicitation, and if required, the specific issues of individual documents referenced (see 2.1.1 and 2.2).
- c. When a first article is required (see 3.1, 4.3 and 6.3).
- d. Levels of preservation and packing (see 5.1 and 5.2).
- e. When palletization is required (see 5.3).
- f. Acceptance criteria required (see 6.5).

6.3 First article. When a first article is required, it shall be inspected and approved under the appropriate provisions of FAR 52.209. The first article should be a preproduction sample. The contracting officer should specify the appropriate type of first article and the number of units to be furnished. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for selection, inspection, and approval of the first article.

6.4 Sources of Supply. The following listed manufacturers parts have been found to meet the requirements of the items listed with minor alterations to some of the items.

- a. Franz Heinze KG
Postfach 131314
D-5600 Wuppertal 13
W. Germany

<u>Item</u>	<u>Part No.</u>	<u>Franz Heinze Part No.</u>
Burner Assembly	6-1-8847	6215
Preheater Assembly	6-1-8848	6217
Seal Assembly	6-1-8857	6219
Jet, Burner	6-1-8856	6250
Needle Assembly	6-1-8852	6251

- b. Optimus International
P.O. Box 1950
1100 Boston Avenue
Bridgeport, CT 06601

<u>Item</u>	<u>Part No.</u>	<u>Optimus Part No.</u>
Fuel Cap Assembly	6-1-8849	2912
Tube, Restrictor	6-1-8858	5163

6.5 Acceptance criteria. The acceptance criteria below is recommended for use. The acceptance criteria as specified in the contract or purchase order shall be binding. Unless otherwise specified, the following acceptance criteria are in accordance with MIL-STD-105.

6.5.1 For end item visual examination. An AQL, expressed in terms of defects per hundred units, of 2.5 for major defects and 4.0 for minor defects is recommended.

6.5.2 For end item dimensional examination. An AQL, expressed in defects per hundred units, of 4.0 is recommended.

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6.5.3 For end item testing. An AQL, expressed in terms of defects per hundred units, of 1.0 is recommended.

6.5.4 For packaging examination. An AQL, expressed in terms of defects per hundred units, of 2.5 is recommended.

6.5.5 For palletization examination. An AQL, expressed in terms of defects per hundred units, of 6.5 is recommended.

6.6 Subject term (key word) listing.

Burner
Field equipment
Food cooking equipment

Custodians:

Army - GL
Navy - YD

Preparing activity:

Army - GL

Review activities:

Army - MD, TS
DLA - GS

(Project 7310-A755)

User activity:

Navy - MC